Time Patterns Relation in Assisted Automated Scheduling

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***Abstract* — In the paper there is discussed problem of time patterns relations in the process of assisted automated scheduling. There is described a relationship between events time description method and computational cost of scheduling process. There is presented analysis of the impact of time patterns definition to flexibility of processing algorithms. Discussion of description method effectiveness is presented and conclusion is drawn.**

Keywords — assisted scheduling, time patterns, timetabling

I. INTRODUCTION

Assisted automated scheduling and timetable creation is an important issue in various aspects of human life, because of wide need of controlling the schedule and optimization of logistic relations in time and space. It would be difficult to imagine for example efficient functioning of any logistic process or school education without existing of properly designed schedules, taking account all mutually exclusive dependences of processes and ensuring optimal usage of available resources.

Computational complexity of timetabling problem makes impossible to use the classic algorithms to solve it in polynomial time. Previous attempts of approach to automate the timetable creation process were based on various kinds of heuristics so there is a good chance to receive an acceptable result, however there is always a risk that we were unable to obtain a result, even if it exists. Furthermore every modification of base parameters causes significant changes in received result which involves necessity to create completely new timetable for every set of constraints and conditions.

As the result of requirement of matching the method of data and conditions description to work with particular algorithm there is no unified way of description allowing to define any kind of constraints and conditions. Unfortunately most of the algorithms are based on very simplified schedule models what prevents their universal application, and any change of model structure results the need of modification of the algorithm itself to handle additional dependencies. Too high level of model complexity increases the computational cost often to a level above viability point of use of such method.

The issue of study of time patterns relations in the assisted automated scheduling process and their impact on the effectiveness of the aided planning algorithm is the subject of numerous publications [1, 2, 3, 4]. In this paper there are presented results of studies on formal description methods of optimal inference path for the assumed class of applications.

II. TIME PATTERNS AND PATTERNS RELATIONS

The analysis of issue can conclude that the time patterns can be represented as the form of discrete linear functions, which allows to get a convenient description in terms of usage flexibility and reduction of calculations cost. Treating schedule as the deployment of resources and tasks in time and space it is easy to notice that the main factor affecting both the acceptability and degree of optimality of schedule is the location in the time dimension. The dominating type of events in complex, long-term schedules are cyclical events, which involve the same resources in the same or another location according to own sub-schedule. The analysis of the events time dependences including the cyclical events increases significantly complexity of the algorithm and the computational cost due to the need of treating single cyclical event as a series of individual subsidiaries events.

Let's define an Individual Event *IE* as a single and unique process definition along with definition time period of its progress and involving specific, identical resources.

Let's define a set of all possible events in the modeled system as

$$SE = \sum_{i}^{I} \sum_{j}^{Ji} \sum_{k}^{Kj} \left(IE_{x,k} + EI_{x,k} \right) \tag{1}$$

where:

SE – sum of all events in modeled system,

I – number of different Individual Events *IE*,

Ji – number of cycles in a cyclic event i,

Kj – number of Individual Events *IE* in a cycle j,

$IE_{x,k}$ – Individual Event of type x in a cycle j,

$IE_{x,k}$ – Event Interval for Individual Event of type x in a cycle j.

As one can notice, the single event location is a point in two-dimensional discrete space. Those dimensions are series of

available locations and set of time slots fulfilling conditions of particular events.

Verification of created schedule requires checking whether each single point in space corresponds to one and only one event. In case of cyclic events it is required to identify the original time windows corresponding to the definition of the cycle and then to analyze relations between every single individual event *IE*. Detection of a single conflict for any individual event in a given cyclic event means a conflict situation for this cyclic event.

In schedules based mainly on cyclic events, such a situation causes significant increase of computation complexity proportional to the number of individual elements per one cycle definition. In addition frequently one cyclic event consists of more than one sub-schedule contains separate cycle definition what results further increase of computation cost.

Definition of a single cycle of event includes the time constraints which limits the individual event execution and the event interval. The interval can be defined either as the distance between the individual events and by the coordinates based on calendar time, such as the specific day of the month. Detection of cycles conflicts is achieved by looking for common points that meet the definition of all cycles compared with each other. The comparisons are made on all cycles related to events occupying the same localization.

III. SUMMARY

As shown, the issue of modeling the time patterns used in process of assisted automated scheduling is essential in domain of support of planning and the logistics processes modeling and optimization. Proper preparation and verification of the model allows to achieve significant savings in the computational cost of realization and it also leads to shortening of time needed to achieve desired result. What's important, achieving of the desired result makes sense only if it will be available timely – exceeding that limit often makes whole results to be useless and the whole process must be started from the very beginning because of the change of input conditions.

Further research will be aimed at developing efficient way to use existing methods of description of time patterns relations to solve the problem of describing the optimal inference path for the assisted automated scheduling for assumed range of applications. A promising method seems to be an attempt to obtain a formal description of set of the time patterns connected to a single event in the form of structure, allowing application of analytical mechanisms for increased efficiency and flexibility than the previously used analysis of common points of functions defined by the time patterns. For this purpose, there are plans to use the mechanism of heuristic analysis.

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